4.—TERTIARY DEPOSITS NEAR NORSEMAN, WESTERN AUSTRALIA

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(With an Appendix by IRENE CRESPIN.)

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CONTENTS.

I. INTRODUCTION.

1. LOCALITY.

Norseman, one of the most southern gold-mining towns of Western Australia, is about 350 miles east of Perth and 100 miles north of the southern port Esperance. It lies on an auriferous "greenstone" belt on the east shore of Lake Cowan and is connected by rail with Esperance and with Coolgardie on the Trans. Australian Line.

Gold was discovered in the Norseman district in 1892 and is still being produced: the output in 1943 was about 40,000 oz.

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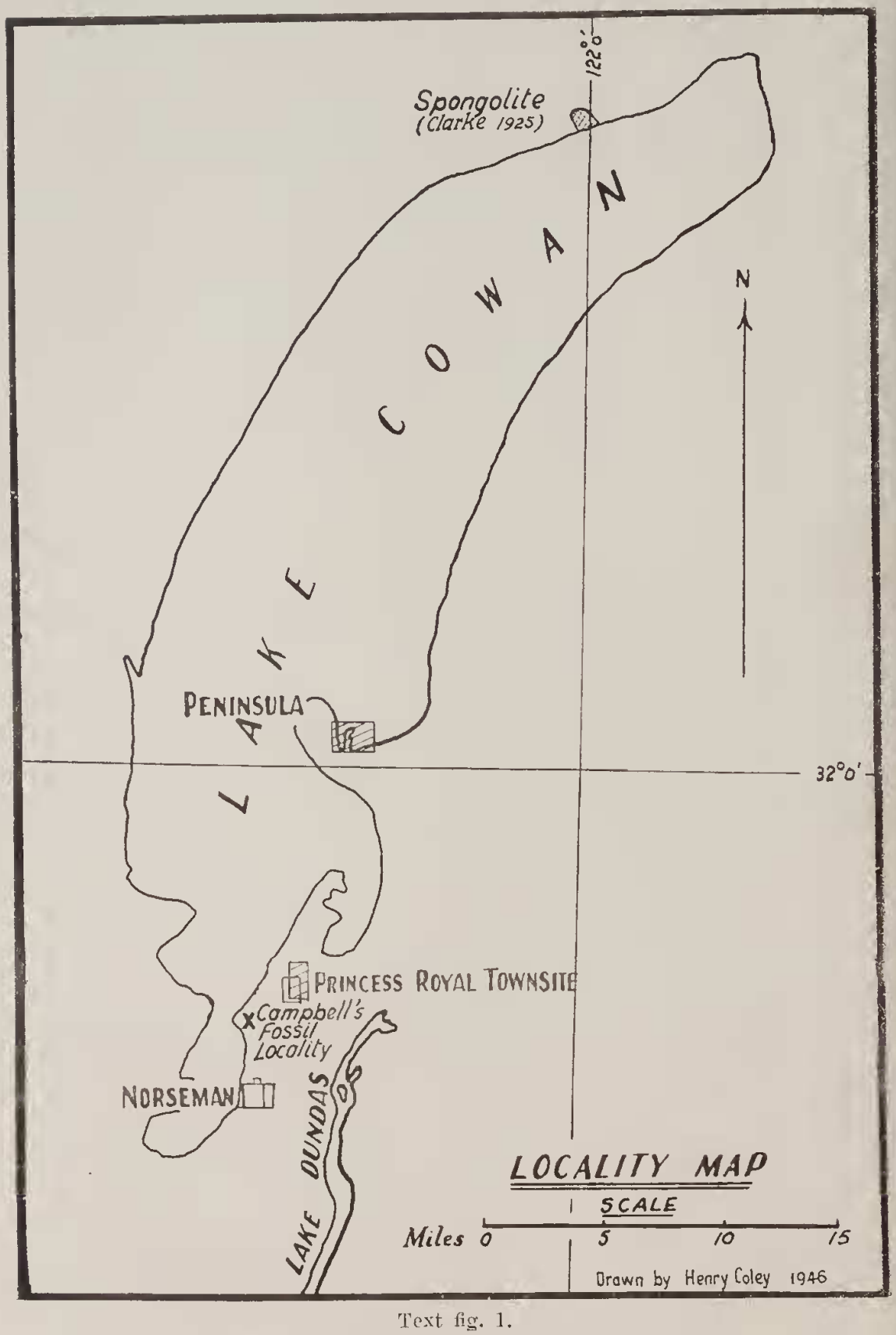

Text fig. 1.
Locality Map showing occurrences described in this paper.

2. TOPOGRAPHY.

The average annual rainfall of this part of the State is about 10 inches and the average evaporation is well over 100 inches; consequently Lake Cowan, like the many lakes farther inland, is nearly always dry.

The floors of the salt lakes of Western Australia are almost perfectly smooth and, after heavy rain, may for a short time be covered with water which is rarely as much as three feet deep.

Lake Cowan, and Lake Dundas 5 miles farther east, occupy shallow depressions, about 900 feet above sea-level which are elongated in a north-south direction approximately parallel to the strike of the Pre-Cambrian rocks on which they lie. A bore sunk in 1896 in the lake-bed just west of Norseman traversed 377 feet of lacustrine muds before reaching Pre-Cambrian rocks (Campbell, 1906, p. 15), so that the depth of part of the depression occupied by Lake Cowan was once of the order of 400 feet.

Most of the auriferous greenstone belts of Western Australia are more hilly than the surrounding country, apparently because the greenstones are more resistant to the agents of arid erosion than are the other rocks of the Pre-Cambrian complex, but the Norseman greenstone belt with its long, narrow, steep, north-trending ridges and v-shaped valleys shows unusually high relief. A large dyke of norite (Campbell, 1906, p. 24 and fig. 5) with an easterly strike forms a line of hills cutting across the

Text fig. 2.

Norseman and the southern part of Lake Cowan from the ridge just east of the town.

greenstone ridges: it appears to continue for many miles across the plain country which borders the greenstone belt and which is probably composed of the more easily eroded "whitestones" of the Kalgoorlie-Yilgarn System.

3. PREVIOUS WORK.

Fossiliferous deposits in this district were discovered by W. D. Campbell. He described them briefly (1906, p. 22), as a "unique opalized remnant of an old sea beach at about 35 feet above the present level of Lake Cowan containing either late Tertiary or Recent marine shells, such as *Turritella, Pecten, Cardium* or *Cardita,* and *Magellania,* and numerous fragments of other shells, *Echinii* and *Polyzoa.*" He also found several outcrops of unfossiliferous dolomite (*loc. cit.* p. 21) in the area north and north-east of Norseman which he regarded as being of the same age, presumably Tertiary.

Mr. Gibb Maitland, the State Government Geologist at that time, stressed (1907) the interest of Campbell's discovery. Hinde (1910) reported on some siliceous rocks from a "deep lead" (the inverted commas are Hinde's) at Princess Royal Township, eight miles north of Norseman. This deep lead had been discovered in 1901 (Woodward, 1902) and gold had been obtained from it at a depth of 88 feet. Hinde found that the rock penetrated by the workings was a spongolite in which he identified many different types of sponge spicule. Its relationship to the gold bearing rocks was not recorded. He suggested that the spongolite is probably "newer than Cretaceous" in age.

That spongolite rocks have a wide distribution in the Norseman district was suggested by the discovery (Clarke, 1925, p. 12) of low cliffs of sponge spicule rock on the north shore of Lake Cowan, about 30 miles N.N.E. of Princess Royal.

Although no further field investigation of the fossiliferous rocks had been made, Gregory (1916) suggested, mainly from the identification of some Bryozoa, that the rocks in which Campbell had found marine shells were of Miocene age.

Chapman and Crespin (1934) published determinations of a number of pelecypod and gastropod species and of one brachiopod (*Magellania insolita*) from Campbell's "opalized sea beach", but they did not discuss the age of the beds, though it is clear from the context of their paper that they regarded them as Miocene.

4. PRESENT INVESTIGATIONS.

It is obvious that the occurrence of Tertiary rocks so far inland on the Pre-Cambrian shield throws light on the later geological history of this part of Australia but no further field study of the fossiliferous beds had been made since Campbell's time, until in 1943, Mr. H. W. B. Talbot informed us of the discovery of a new fossil locality at the Peninsula, 15 miles north of Norseman, and gave some specimens of fossiliferous limestone to the Department of Geology. In May, 1944, we were able to spend two weeks in the Norseman district examining the fossiliferous and other sedimentary deposits along the eastern side of Lake Cowan between Norseman and the east coast of the Peninsula, including the

Princess Royal deposits. We also visited an area near the northern end of Lake Dundas, where Campbell had reported the occurrence of unfossiliferous dolomites.

5. ACKNOWLEDGMENTS.

The expenses of the excursion were defrayed by the Commonwealth Research Grant to the University of Western Australia. Transport in the Norseman district was generously provided by Central Norseman Gold Mines. We wish to express our gratitude to Mr. W. Lindesay Clark, director of the Western Mining Corporation, to Mr. H. W. B. Talbot, geologist to the Corporation, and to Mr. W. Dutton, superintendent of the Central Norseman Gold Mines for their courtesy and help, without which these observations could not have been made. We are also indebted to Dr. R. T. Prider for help in revising the text.

II. SITUATION OF OUTCROP AREAS OF THE TERTIARY SEDIMENTS.

So far as known at present the Tertiary sediments occur in patches, isolated by erosion, along the east side of Lake Cowan and near the north end of Lake Dundas about five miles north-east of Norseman. The occurrences which we examined may be grouped into the following five "outcrop areas":—

(1) Campbell's "opalized sea beach," three miles north of Norseman.

(2) The spongolite deposits which underlie part of the old Princess Royal Townsite and extend west of it. To the north, between Princess Royal and Lake Cowan and on the shores of the lake itself are several disconnected patches of unfossiliferous dolomite which might be included in this outcrop area.

(3) A number of limestone and dolomite outcrops, mostly fossiliferous, along the north side of the Peninsula, about 15 miles north of Norseman.

(4) Unfossiliferous dolomite outcrops on the north shore of Lake Dundas, five miles north-east of Norseman.

(5) A spongolite occurrence at the north end of Lake Cowan. This was visited by one of us (E. de C.C.) many years ago.

It is to be expected that a close survey of the shores of Lake Cowan and Lake Dundas will reveal the presence of additional outcrops.

III. ROCK TYPES.

There are three main rock types in these Tertiary deposits:—spongolite, unfossiliferous dolomite, and fossiliferous limestone and dolomite.

1. The *spongolite* is porous, white to orange-red in colour, and very light in weight. It is composed of the spicules of siliceous sponges of which many species were identified by Hinde (1910). Associated with the typical spongolite are beds of blue clay and white shale only a few feet thick. The blue clay is a light bluish-grey rock with occasional white

spots up to 15 mm. in diameter and irregularly scattered reddish-brown spots. Microscopic examination and heavy mineral determinations showed that it is largely composed of extremely fine particles of clay minerals with a smaller amount of fine-grained, angular quartz, iron ores, and hypersthene; the hypersthene was no doubt derived from the adjoining norite dyke which was mentioned in the introduction. The white shale is exceedingly fine-grained, white, and slightly friable and contains a minute amount of very fine-grained quartz, iron ores, and hypersthene. Sponge spicules occur in both rocks but are not numerous.

2. The *unfossiliferous dolomite* (Campbell, 1906, p. 21) is a hard, white, fine-grained rock. Staining tests (Rodgers, 1940) show that it is an almost mono-mineralic dolomite containing occasional fragments of quartz up to one mm. in diameter and still rarer rounded bodies of ferruginous material up to three mm. in diameter which may be concretions but are more probably pebbles. Neither fossils nor any sign of bedding can be seen in this rock which is included in the Tertiary series because it overlies the Pre-Cambrian rocks and occurs near strata known from their fossils to be Tertiary in age.

3. There are several varieties of *fossiliferous limestone*. Some are unaltered, others have been changed diagenetically to siliceous or to dolomitic rocks. They vary in character even in one outcrop, and will therefore be discussed in the next section.

IV. DESCRIPTION OF OUTCROPS.

1. CAMPBELL'S "OPALIZED SEA BEACH."

A very gently undulating area of about 100 acres covered with unfossiliferous dolomite (Campbell, 1906, fig. 11) occurs near the Norseman end of the causeway over Lake Cowan, about three-and-a-half miles north of Norseman on the south side of the great norite dyke. At the eastern end of this occurrence there are two small fossiliferous outcrops, about 40 yards apart which underlie the unfossiliferous dolomite. About 100 yards farther east is a knoll over which are scattered many fragments of chrysoprase. The fossiliferous rocks are opalized and it is difficult to determine their original characteristics, but there appear to have been three types:—

(a) Fine laminated sandstone.

(b) Very fine-grained mudstone with conchoidal fracture and few fossils.

(c) Sandy limestone with opalized fossils and rounded to angular sand grains.

The sandy limestone is more fossiliferous than the other two, but the fossils are very much altered diagenetically and good specimens are hard to obtain.

Miss Irene Crespin (see Appendix) has determined the following Bryozoa from this locality:—*Macropora clarkei* (T. Woods), *Amphiblestrum sp.*, *Hincksina geminata* (Waters), *Cellepora fossa* (Haswell), *Adeonellopsis elavata* (Stol.), *Retepora aciculifera* McG., *Crisia acropora* Busk.

Some years ago Chapman and Crespin (1934, p. 126) gave a list of fossils, other than Bryozoa and sponges, from "Norseman". Since no other

fossil beds, with the exception of the Princess Royal spongolite, were then known from the district, these fossils must have come from Campbell's discovery. The list is as follows:—*Magellania insolita* (Tate), *Lima bassi* (T. Woods), *Venericardia spinulosa* (Tate), *Venericardia cf. scabrosa* (Tate), *Corbula* sp., *Turritella tristria* (Tate), *Semiactaeon microplocus* Cossm.

Most of these species have also been recognized in our collections from this locality. We also found representatives of the following:—

Glycimeris sp., *Barbatia* sp., *Cardita* sp., *Cardium arcaeformis* (Chapman and Crespin), *Chlamys aldingensis* (Tate).

Our collection also includes some unidentified gastropods, one or two corals, *Cidaris* spines, and a columnal of *Pentacrinus*.

2. PRINCESS ROYAL.

Spongolite beds occupy an area about one mile long and a quarter mile wide, in the vicinity of Princess Royal (Plate I). As mentioned above, the spongolite was first discovered in the deep lead under the main street

Text fig. 3.

Breakaway of spongolite, three-quarters of a mile north-west of Old Main Shaft, Princess Royal.

of Princess Royal, but there are rather extensive outcrops in a gully which runs north just west of the townsite and in low breakaways north-west of the townsite.

Text fig. 4.

Contact of Pre-Cambrian and Tertiary rocks in a small gully about eight feet deep, 40 chains west of Old Main Shaft at Princess Royal townsite. Weathered Pre-Cambrian rocks are exposed in the bottom of the gully, blue clay and white shale along the sides. The contact is marked by a black line.

The sediments lie with marked unconformity on Pre-Cambrian rocks which appear to be chiefly amphibolites with occasional porphyry dykes and to belong to the Kalgoorlie-Yilgarn System. The surface of the Pre-Cambrian, at its contact with the spongolite series, is weathered and uneven and is overlain by two feet of blue clay; then come two to four feet of white shale, followed by a bed of spongolite 20 to 25 feet thick which in some places is white and is composed very largely of sponge spicules; in others, where it is red, spicules are not nearly so abundant. These three beds are conformable.

The sediments thicken as we approach L. Cowan because they occupy a north-south depression in the Pre-Cambrian rocks which deepens northwards. On the west, south, and east sides Pre-Cambrian rocks constitute

the higher ground so that their contact with the sediments can be mapped, whereas the northern boundary is obscured by alluvium.

The dumps along the deep lead contain spongolite, siliceous oolite, and an oolitic carbonate rock. The oolitic rocks are not found at the surface, and, all the shafts being inaccessible, it can only be assumed that they occur somewhere in the Tertiary series.

About 200 yards north of the last spongolite outcrop is an exposure of dolomite north-west of which there are six or seven others all mapped by Campbell (Campbell 1906, fig. 3). They are all unfossiliferous. The relation of the spongolite to the dolomite has not been seen but the base of the spongolite is about level with the top of the dolomite.

The only palaeontological work on the spongolites was done by Hinde (1910). He considered that the spicules were identical with or closely similar to, those of the following forms previously described:—Monaxonid. *Latrunculia; Desmacidon* (*Homaeodictya*) *grandis* Ridley and Dendy; *Petrosia variabilis* Ridley; *Halichondria infrequens* Carter; *Strongylophora durissima* Dendy; *Forcepia crossanchorata* Carter; *Tethya* Lam., *Myrilla hastata* Ridley and Dendy.

Tetractinellid. *Stelletta reticulata* Carter; *Erylus* Gray; *Craniella* Schmidt; *Cydonium mulleri* Fleming; *Geodia zetlandica* Johnston.

Lithistid. *Ragadinia* Zittel; three species of *Discodermia* Bocage; *Corallistes* Schmidt; *Theonella swinhoei* Gray; *Vetulina* Schmidt; *Dactylocalycites* Carter.

Hexactinellid. *Rossella antarctica* Carter.

3. PENINSULA.

The shore of the Peninsula is broken into small bays, islands, sandspits, and promontories (Plate II). Outcrops which we call A, B, and C, of horizontal or very nearly horizontal fossiliferous limestone occur in three of the bays, the shores of which are generally steep banks, in places undercut, two to 15 feet high, formed by various agents of arid erosion and by very occasional corrasion by the lake water. In some of the bays there is a "laterite" layer two to three feet above the bed of the lake but well below the present soil surface.

Locality A is the west bank of the most southern of the bays. The outcrop at locality B in the third bay north of this extends across the floor of the lake to the north side where it disappears under a sand ridge 100 yards wide, on the other side of which, in the next bay, is locality C— a limestone bank 12 feet high and 130 yards long.

Thin sections show that the Tertiary rocks at the Peninsula are composed of fine-grained matrix of dolomite and ferruginous material in which there is a varying percentage of complete or fragmentary fossils with angular, medium-grained quartz particles and more rounded ferruginous fragments and concretions, up to two mm. in diameter. Staining (Rodgers, 1940) shows that calcite occurs only in some of the casts, replacing the original shelly matter, but in most instances the replacing material is dolomitic, and, in some places it is secondary ferruginous matter.

Text fig. 5.
Limestone cliff at Locality A, on the Peninsula, Lake Cowan.

Locality A is a miniature, almost vertical cliff of fossiliferous limestone extending for a quarter of a mile along the west side of the bay. It is 12 feet high and flat-topped at the southern end, but only two or three feet high at the northern end. Like the outcrops at the other localities at the Peninsula it shows great lateral variation in lithology and fossil content. The cliff for 200 yards from the southern end of the outcrop is composed of a hard, massive, light yellow-brown limestone, of which algal fragments and concretions constitute as much as 40 per cent., and echinoid spines and plates, and rare pelecypods five per cent.; the matrix is partly dolomitic and partly ferruginous. For the next 100 yards farther north small pelecypods are very numerous, but Bryozoa and a few gastropods and brachiopods also occur. The section here is 12 feet thick and shows distinct vertical variation in colour and texture. Lensing bands of shell grit compose the upper five feet, well-preserved fossils being found only in the lower seven feet. For the next 50 yards farther north the rock is a dolomitic limestone, being made up in great part of Bryozoa with very subordinate numbers of brachiopods and echinoids. The exposed thickness of this bryozoan limestone is between four and five feet. Outcrops are discontinuous farther to the north, where algal concretions with less frequent gastropods and

pectinids occur. The rock is very similar lithologically to the algal limestone at the southern end of Locality A.

Among the more common fossils are *Barbatia dissimilis* Tate, *Cardium arcaeformis* Chapman and Crespin, *Venericardia* sp., *Chlamys murrayana* (Tate), and *Chlamys aldingensis* (Tate). In addition the limestone contains two species of brachiopods and several species of gastropods, as yet unidentified. In samples from the same deposit Miss Irene Crespin has found twelve species of cheilostomaceous and cyclostomaceous Bryozoa (see Appendix).

Locality B consists of four disconnected outcrops on the lake-bed. On the northern shore of the bay the exposed thickness of the bed is two to three feet, elsewhere only one foot is visible. There is considerable lateral

Text fig. 6.

Limestone exposures on lake floor at Locality B, on the Peninsula, Lake Cowan.

variation of species in these disconnected outcrops although they are probably all of the same bed. About 10 chains from the southern headland of the bay is a very fossiliferous limestone composed almost entirely of gastropods. After deposition the shells were dissolved, leaving cavities which have since been lined with crystalline calcite so that the external features

of the shells have been lost. The other outcrops are less fossiliferous, containing but a few species of gastropods, pelecypods, Bryozoa, and some echinoid spines. On the north shore of the bay the limestone is very massive and rather similar lithologically to the algal limestone of Locality A but algal concretions are rarer.

The gastropods in this deposit seem to belong to such genera as *Marginella*, *Natica*, *Fusus*, *Bullaria*, and possibly others as well. Among the pelecypods *Barbatia dissimilis* (Tate), and *Cardium arcaeformis* Chapman and Crespin, could be recognized. Some *Cidaris* spines are also present.

At *Locality C* limestone is exposed almost continuously for a distance of about 130 yards in a cliff rising in places to 20 feet above the lake floor. It shows the usual lateral variation in fauna and some lensing of the beds.

Text fig. 7.
Locality C, on the Peninsula, Lake Cowan.

The beds are generally horizontal except at the western end where for a few feet there is a dip to the south of 30° probably due to the action of growing roots and of slumping consequent on undercutting.

The lowest layer of the limestone is about eight feet thick and contains very numerous complete pectinid shells, the lower one or two feet being grey

with a light-coloured yellow-brown limestone above. A layer about five feet thick and made up almost entirely of fragments of Bryozoa overlies the pectinid bed. Dolomite two feet thick forms the top of the section and a superficial calcareous travertine rock, a product of arid weathering, overlies the dolomite. The number of species in this deposit is small.

The predominant pectinids are *Chlamys murrayana* (Tate) and *Chlamys aldingensis* (Tate). Other pelecypods include *Modiolaria* cf. *arcacea* (Tate).

4. LAKE DUNDAS.

Dolomite.—At the extreme north end of Lake Dundas, about five miles north-east of Norseman, there are scattered outcrops of unfossiliferous dolomite on the edge of the lake and farther inland. A considerable thickness of superficial gravel and finer alluvial material forms low headlands and terraces along the west side of the lake and in them dolomite crops out. Several short gullies, a mile or two long, which drain the hills of Pre-Cambrian greenstone enter the lake near its northern end and have exposed other patches of dolomite but nowhere is its contact with the Pre-Cambrian visible. Most of the smaller patches are shown on Campbell's map, but the largest which is farthest north-east, on the lake shore near an old track to Israelite Bay, is outside its limits. It is a conspicuous white hill over 100 yards long and rising steeply to about 40 feet above the lake, into which it extends as a narrow headland for about 70 yards. The hill consists of dolomite which is a massive, crystalline, almost monomineralic rock with occasional angular quartz fragments and rounded limonitic pebbles as in the dolomites described earlier in this paper. Weathering of this rock produces a rough, sculptured surface. Low outcrops extend south-west from the hill for 150 yards and the rock appears again in a promontory about 250 yards south of the hill where it is overlain by gravel.

Eucalypt Beds.—Campbell (1906, p. 22) reported the occurrence of silicified specimens of true eucalypt wood (determined by R. Etheridge Jun.) "on the valley flat of the Mary Cater Gully and on the laterite flat on the north side of Israelite Bay Track near Lake Dundas. In the latter locality it occurs in a semi-chalcedonized matrix." Campbell and Etheridge suggested that the wood-bearing strata may be part of the Tertiary series. We were unable to visit the locality.

5. NORTH SHORE OF LAKE COWAN.

The sponge spicule beds at the north end of Lake Cowan were not visited on this trip. Clarke reported that they form "low white cliffs overlooking a small bay on the north shore of Lake Cowan south of the Paris Group." He mapped the approximate outline of the occurrence and submitted a specimen to Simpson (Clarke, 1925, p. 13) who described it thus:—

"The rock is moderately tough, very fine-grained and carries no carbonates. Under the microscope it is seen to be a fine-grained marine silt composed of kaolin and finely-divided quartz with a few recognisable sponge spicules in some bands, and in other bands innumerable siliceous spicules, both hexactinellid and lithistid. There is little doubt that this is an outlier of the Miocene Plantagenet Beds."

V. CORRELATION AND PALAEOGEOGRAPHY

A complete examination of the faunas of the various fossiliferous deposits described in this paper has not yet been made. From a study of the Bryozoa in the rocks of Campbell's "opalized sea beach" and in the limestones at the Peninsula, Miss Crespin (see Appendix) concludes that they are of Middle Miocene age. Other palaeontological evidence is not at variance with this conclusion.

At present there is no evidence as to the age of the sponge spicule deposits of Princess Royal, except the statement by Hinde that it is probably younger than Cretaceous. The stratigraphic evidence presented in this paper is, of course, far from conclusive, but if the fossiliferous beds of Campbell's "opalized sea beach" underlie the unfossiliferous dolomite, if this dolomite is contemporaneous with that north of Princess Royal, and if the latter overlies the spongolites, then it would appear that the spongolite is Middle Miocene.

The base of the sediments is everywhere about 900 feet above sea level. As to the conditions under which the spongolites were formed Hinde (1910, p. 21) stated—

"It seems to me that this Norseman sponge-rock is not a merely local deposit, but that it was formed in the open ocean, at some distance from a coastline, so as to be away from sediment-bearing currents, and probably at a considerable depth. The sponges which furnished the materials of the deposit may have lived, died, and been disintegrated in the same area."

The blue clay and white shale below the spongolite at Princess Royal suggest that sedimentation began under still-water conditions. The amount of coarser detrital matter increases higher up in the sequence, some of the spongolites being quite sandy. The surface of Pre-Cambrian rocks on which the sediments rest is uneven, suggesting a period of subaerial erosion before submergence.

The fossiliferous limestones and dolomites are rather free from detrital material so that they may have been deposited at some little distance from the shoreline. On the other hand many of the shells are broken, and, in the outcrop C at the Peninsula, there is a layer which is almost exclusively composed of worn and rounded fragments of small Bryozoa. It seems likely, therefore, that these beds were formed in rather shallow, disturbed water.

The geographical position of the Norseman sedimentary area is intermediate between the huge limestone platform of the Nullarbor Plain which begins 100 miles farther east and the smaller area, occupied by the Plantagenet Beds, which stretches westward along the coast from the neighbourhood of Ravensthorpe, 150 miles south-west of Norseman. Both the Eucla limestone of the Nullarbor Plain and the Plantagenet Beds are of Miocene age, and it seems most likely that the Norseman sediments are remnants of a sheet of sediments which must have once covered a considerable area of the southern part of the Western Australian shield.

The Miocene transgression in Western Australia has been discussed in recent papers by Clarke (1935) and Teichert (1944). These writers

have suggested that at the time of maximum submergence the surface of the shield might have stood about 1500 feet lower than now, i.e., that the sea which covered the area with which this paper deals might have been about 600 feet deep. The sea was almost certainly shallower than this—possibly not more than about 60 feet deep—when the fossiliferous limestones were deposited. Perhaps soon afterwards the sea-floor emerged and the Post-Miocene period of denudation began.

Miss Crespin in the appendix suggests interesting correlations of the Norseman beds with the Balcombian deposits in Victoria and in South Australia.

VI. APPENDIX.

NOTES ON THE BRYOZOA FROM LIMESTONES AT LAKE COWAN AND NORSEMAN, WESTERN AUSTRALIA

By

IRENE CRESPIN.
(Commonwealth Palaeontologist.)

The preservation of the Bryozoa in the limestones from the above localities is poor, the majority of the specimens being very worn and encrusted. Consequently specific determination of forms is limited.

The following species have been recognized:—

1. LIMESTONE CLIFF, OUTCROP A, PENINSULA

(a) Cheilostomata.

Macropora clarkei (T. Woods)
Cellaria depressa (Maplestone)
Cellepora fossa (Haswell)
Porina gracilis (M. Edwards)
Retepora sp.
Schizellozoon permunitum (McG.)

(b) Cyclostomata.

Spiroporina verticillata (Goldf.).
Mecynoecia proboscidea (M. Eds.)
Idmonea incurva (McG.)
Idmonea sp.
Tecticavea cf. *schnapperensis* (McG.)
Lichenopora radiata (Audouin)

2. CAMPBELL'S "OPALIZED SEA-BEACH" NORSEMAN

(a) Cheilostomata.

Macropora clarkei (T. Woods)
Amphiblestrum sp.
Hincksina geminata (Waters)
Cellepora fossa (Haswell)